Japanese Research Plan in the Bering Sea during Summer of 2004 for BASIS

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Introduction

Unanticipated changes in the ocean productivity of Bering Sea ecosystem are affecting Asian and North American societies and economies through reduction and possible elimination of important commercial and subsistence fisheries. An international effort is required to detect and monitor changes in salmon and their ecosystem because stocks from all major salmon producing nations are distributed in the Bering Sea, intermingle in international waters, and migrate across the national economic zones. At the 2001 annual meeting of the North Pacific Anadromous Fish Commission (NPAFC), Canada, Japan, Russia, and the United States agreed to plan and coordinate a new international program that will form the basis for long-term, large-scale ecosystem research on salmon in the Bering Sea (NPAFC 2001).

The somatic growth of Japanese chum salmon is affected by offshore environment in the North Pacific Ocean (Ishida et al. 1993). Environment in the Bering Sea may be a key to determine the somatic growth of Japanese chum salmon, because Japanese chum salmon are distributed in the Bering Sea during the summer growth period (Urawa 2000). Japan continues to monitor summer salmon stocks and environments in the Bering Sea using research gillnets since 1992. However, data of the monitoring research is not sufficient to estimate abundance of salmon, because of the limited survey area in the central Bering Sea. Thus, we need intensive surveys in the whole areas of the Bering Sea using trawl nets to determine salmon abundance and their ecosystem structures.

Objectives of Research

Our short term (5 years) purpose is to estimate abundance and spatial distribution of salmon by stocks, and basic ecosystem structures in the Bering Sea. Instead of the odd year, 2003, the catch number of pink salmon by *Kaiyo maru* was lower than that of chum salmon. However, catch number of pink salmon by *Wakatake maru* was the highest of all salmon species as expected. This discrepancy of catch number of pink salmon between *Kaiyo maru* and *Wakatake maru* is due to fishing gear. Thus, in the third year, 2004, we will not focus on spatial distribution of salmon only, but accumulate data of fishing efficiencies of trawl and gillnet. The research will be conducted in cooperation with the Bering-Aleutian Salmon International Survey (BASIS) plan (NPAFC, 2001).

Participants

- Fisheries Research Agency:
- National Salmon Resources Center (Sapporo):
- Hokkaido University:
- Scientists from NPAFC contracting Parties (Canada, U.S.A. and Russia):
- Assistant researchers :

Research Vessel

Kaiyo maru (Fisheries Agency of Japan) 2,630 tonne, 3,500 horse power × 2

Tentative Schedule

June 17 –July 16, 2004 for 30 days

Survey Area

The sampling stations are *Wakatake maru* and the BASIS's fixed locations in the Bering Sea (Figure 1).

Field Survey

- **Fish Sampling**

Trawl operation

To catch salmon and other nektonic species, one-hour trawl operation will be made in the surface layer (from the surface to 60 m in depth) with 5 knots towing speed. The net size is 208 m long, 63.2 m head rope, 400 m warp and the cod-end made of 11 mm knotless mesh.

Salmon treatments

All salmon in the catches will be counted by species. The principal biological characters that will be measured include fork length, body weight, sex, and gonad weight. Gonad weight will be used as an index of maturity. Juvenile (ocean age-.0) salmon will be frozen in the round for laboratory collection of length, weight, stomach contents, scales, otoliths, and tissues for genetic analysis. Immature and adult salmon will be sampled aboard the vessel for scales, otoliths, tissues (muscle, heart, liver and brain), and stomach contents for feeding, growth, stock identification, parasite, and neuroendocrine analyses. Tissue samples for genetic analyses will be kept frozen at -80ºC. Some chum salmon will be frozen in the round for parasite and lipid analyses.

Salmon Abundance estimation

The abundance of salmonids in the whole areas of the Bering Sea using trawl nets will be estimated, and compared to those in the Central Bering Sea using gillnet by the R/V *Wakatake maru* in the same time around same time. These surveys will provide that it is adequate to conduct stock assessment of Japanese-origin salmon in the Bering Sea.

By-catch organisms

By-catch organisms will be sorted according to species and measured and its body weights and body lengths will be recorded. Mainly Atka makeral and Pollack will be kept frozen and squids will be kept in a 10% formalin seawater solution.

Requests for samples

- **Zooplankton Sampling**

NORPAC net (vertical tow) with attached flow meter will be hauled vertically from 150 m. The BONGO NET (nighttime) will be hauled with an angle of 45° from 100m with 0.2 m/s hauling speed. The sampling will be carried out at each depth layers from 500 m to surface, 0-500m, 500-300 m, 300-200m, 200－100m, 100-50m, 50-25m, 25-0m, with changing nets.

Oceanography, DO and Nutrient

Oceanographic observations will be made with CTD before fishing operations. CTD observations will be changed to XCTD observations based on conditions at trawl locations. Several sensors on the CTD "octopus" will collect data (temperature, salinity, depth, and dissolved oxygen (DO)) from 0-1500 meters. CTD Rosette sampling using the 2.5 liter Niskin bottle x 13 depth will be made for collection of the water at the depth of 0 (bucket sample), 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400 and 500 m for salinity and the nutrient, NO_2+NO_3, PO_4, and SiO_3. Investigations of vertical thermal and saline structure (0-1000 m) using XCTD (170 E). Salinity will be confirmed by auto-salinometer analysis. Dissolved oxygen will be measured by titlation method.

- **Acoustic Survey**

Make echo soundering research during daytime at the station of the trawl observation by Simrad EK500. Reduce the cruising speed (8-10 knots) from the site that is 8-10 nautical miles before the fixed station in order to make echo soundering research when we have enough time to survey.

- **ADCP Observation**

Observe the vertical distribution of sea currents using the ADCP system. Currents direction and speed will be measured at multi layers (170E).

- **Solar Radiation**

Solar radiation studies using meteorological radiometer, Print out every 5 min.

- **Other Information on Sea Weather**

Measure and record continuously other meteorological elements on the sea weather using the

automated meteorological monitoring equipment during the entire cruise.

- **Tag Survey**

Sampling of salmon may be done by Hook and line fishing for tag survey.

Laboratory Survey

- **Nutrients Measurements**

Nutrient, NO_2+NO_3, PO_4, and SiO_3 will be analyzed .

- **Scale Analyses**

Ages will be determined by visual examination of scale patterns for all salmon. Scales will be collected from the INPFC preferred area of the fish body. For juvenile salmon, two scales per fish will be collected, placed on gummed cards with the sculptured surface up and impressed in transparent acetate. Procedures for immature and adult salmon will be similar, except that scales will be mounted on gummed cards during shipboard processing. Scale impressions will be provided to scientists in the member nations by request.

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- **Stomach Content Analyses**

The salmon stomachs will be removed and frozen individually. After thawing, the stomach samples will be weighted on a balance before and after removal of stomach contents. The weight of the contents will be obtained by subtraction. A stomach content index (SCI) will be calculated as the ratio of measured prey weight to salmon body weight times 100.

- **Genetic Stock Identification**

Origin of chum salmon will be estimated by allozyme and mitochondrial (mt) DNA analysis. The muscle, heart, and liver are collected from all chum salmon, and immediately frozen at -80ºC for laboratory analysis. The tissues are examined for 20 allozyme loci on horizontal starch gels at the National Salmon Resources Center, Sapporo. At Hokkaido University (Sapporo), DNA is isolated from the liver, and the nucleotide sequences of 500 bp variable portion from the 5' end of mtDNA are examined as described in Sato et al. (2001). We will also test a newly developed microarray system to determine mtDNA haplotypes by using blood samples on board. Stock contributions will be estimated with a conditional maximum likelihood algorithm using SPAM.

- **Otolith Mark Detection**

The left and right sagittal otoliths will be removed from all chum salmon to detect thermal marks. Otolith samples will be examined at the National Salmon Resources Center, Sapporo. The left sagittal otoliths will be mounted sulcus-side up, using thermal resin, on petrographic slides, and then ground to expose primordia. If left sagittal otoliths are not available or are overground, then right sagittal otoliths will be used. Otolith microstructure will be examined under a compound microscope, and the microstructure patterns will be compared to mark patterns from Asian and North American hatchery

voucher specimens. All otoliths will be read independently by a second reader to minimize reader error and provide confidence in readings.

- **Lipid Content Analyses**

Total lipid content (TL) of chum salmon will be determined to estimate their trophic condition. The muscle and liver are collected from frozen round samples of chum salmon caught at four stations (n=100 each) in north, south, central and western waters. At the National Salmon Resources Center, Sapporo, TL will be extracted from the muscle and liver by Folch's method using chloroform/methanol and measured gravimetrically. Lipids were extracted by homogenizing the white muscle (10 g) or liver (10 g) with 50 ml of methanol and 120 ml of chloroform. The homogenate is filtered through a lipid free paper into glass vessel. The crude extract and water are mixed in a separately funnel in the proportions 8:4:3 by volume. The lower phase is collected, and solvent is evaporated with rotary evaporator. Water and protein contents will be also analyzed for several chum samples.

- **Molecular Neuroendocrine Basis Analyses**

The brain, pituitary, gonad and blood will be collected from individual chum salmon to analyze molecular neuroendocrine basis of initiation of homing migration. The brain and pituitary are immersed in cold RNAlater immediately after removal, and the levels of mRNAs for hormone precursors are determined by a real-time PCR method. The gonad is histologically examined to see sexual maturity. The blood is centrifuged, separated into plasma and blood cells, and frozen in a deep freezer. The plasma is later used to analyze the levels of various hormones, while blood cells to determine haplotype for genetic stock identification.

References

Ishida, Y., S. Ito, M. Kaeriyama, S. McKinnell, and K. Nagasawa 1993. Recent changes in age and size of chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean and possible causes. Can. J. Fish. Aquat. Sci., 50: 290-295.

North Pacific Anadromous Fish Commission. 2001. Draft plan for NPAFC Bering-Aleutian Salmon International Survey (BASIS). (NPAFC Doc. 579) 27 p.

Sato, S., J. Ando, H. Ando, S. Urawa, A. Urano, and S. Abe. 2001. Genetic variation among Japanese populations of chum salmon inferred from the nucleotide sequences of the mitochondrial DNA control region. Zool. Sci., 18: 99-106.

Urawa, S. 2000. Ocean migration route of Japanese chum salmon with a reference to future salmon research. National Salmon Resources Center Newsletter, 5: 3-9. (In Japanese.)

Figure 1. Sampling locations in the Bering Sea.

Large numbers indicate station number and small numbers indicate date.